# The Cryo-Thermochromatographic Separator (CTS): A new detection and separation system for highly volatile osmium and hassium (element 108) tetroxides

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We implemented a new concept for heavy element chemistry research using an ion separator to separate the desired products from the beam, transfer products and other undesirable by-products prior to chemical studies. First, a Recoil product Transfer Chamber (RTC) was designed and attached to the Berkeley Gas-filled Separator (BGS) to collect and transfer the recoiling products to the chemical separation system.

The RTC consists of a wire-grid-supported thin mylar foil (≤) 200 μg/cm$^2$ that separates the BGS detector chamber, at 1.3 mbar pressure, from the chemistry system at different pressures ranging from 480 mbar to 2000 mbar. The overall transport efficiency ranged between 30% and 15%, compared to the activity measured in the focal plane detector of the BGS.

The CTS was designed as a separation and α-decay detection system for the highly volatile tetroxides of osmium and hassium, element 108. The CTS, shown in figure 1, consists of two rows of 32-α detectors arranged along a negative temperature gradient. The tetroxides adsorb on the surface of one of the silicone photodiodes at a certain deposition temperature, and the nuclide is then identified by the α-decay. To test the CTS with the expected hassium homologue osmium, different α-active osmium isotopes were produced using the nuclear reactions $^{118}$Sn($^{56}$Fe, 4,5n) $^{170,169}$Os and $^{120}$Sn($^{56}$Fe, 4,5n) $^{172,171}$Os. After pre-separation in the BGS, a mixture of 90% helium and 10% oxygen was used to transport the osmium to a quartz tube heated to 1225 K, where $OsO_4$ was formed. The negative temperature gradient in the CTS ranged from 248 K to 173 K. Using a flow rate of 500 mL/min, most of the osmium activity was adsorbed at a temperature of about 203 K. From the measured α-activity distribution, an adsorption enthalpy of 40±1 kJ/mol for $OsO_4$ on the detector surface was calculated using Monte Carlo simulations. The results show that the CTS is working properly and can be used for experiments studying the chemical properties of hassium.

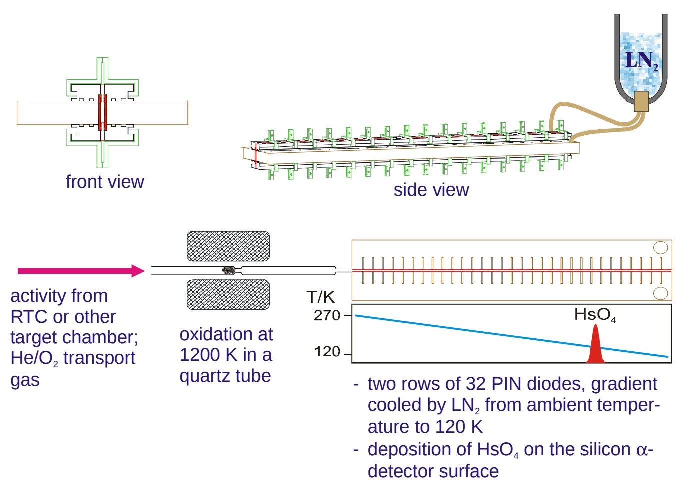


Fig. 1: Schematic and working principle of the Cryo-Thermographic Separator (CTS) and detector that was used to identify volatile osmium tetroxide, a homologue of hassium (Hs, element 108). This experimental set-up will be used for the first chemical identification of hassium.

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